International Microgrid Assessment: Governance, INcentives, and Experience (IMAGINE)

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ECEEE Summer Study

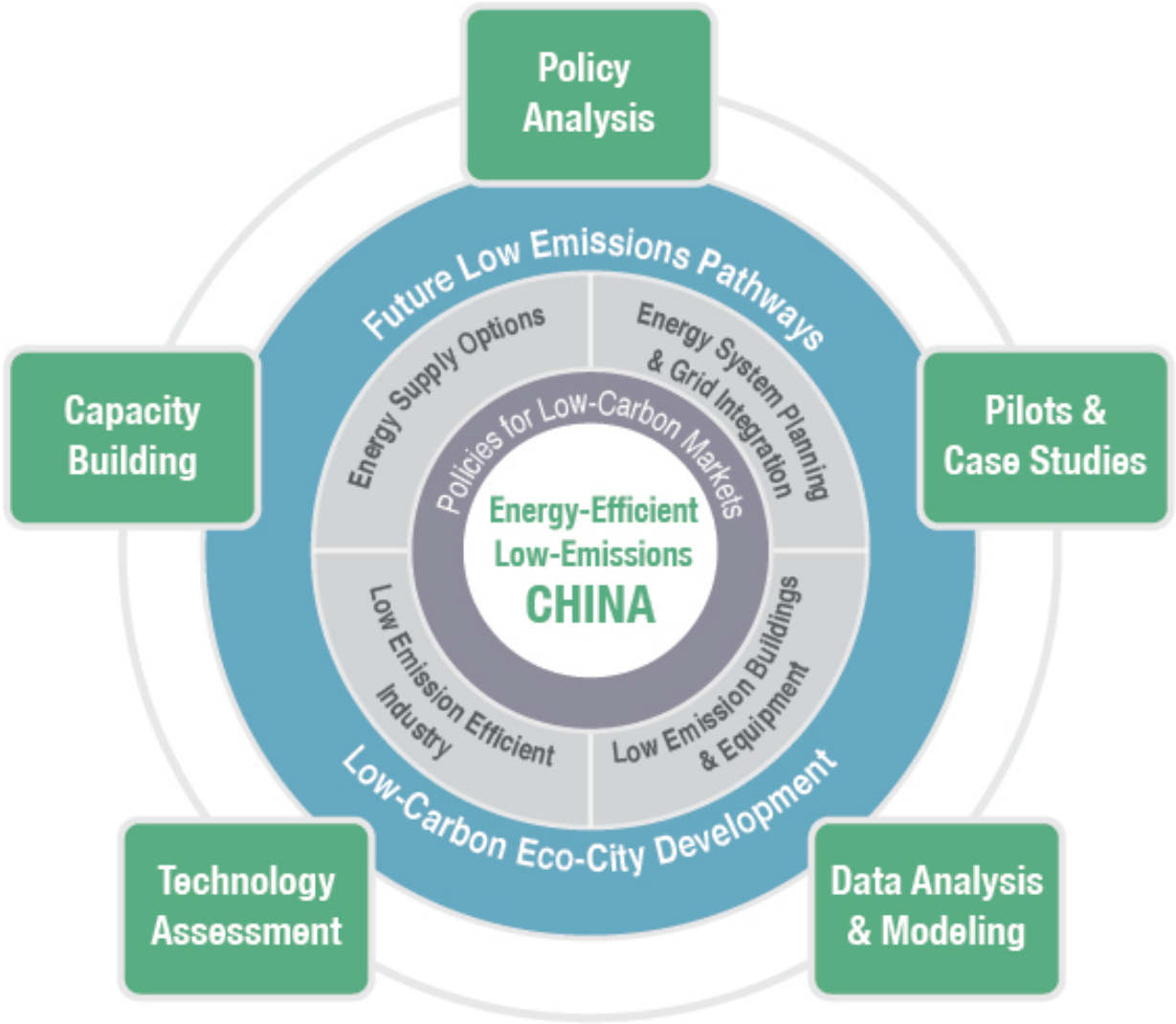
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BERKELEY LAB
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U.S. DEPARTMENT OF ENERGY

University of California

China Energy Group



International Microgrid Assessment

- China's targets in carbon intensity and non-fossil fuel energy
- Grid integration of large scale renewables vs. distributed renewables
- Pilot program of 30 microgrids

INSTITUTE OF ELECTRICAL ENGINEERING,
CHINESE ACADEMY OF SCIENCES

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THE CHINA SUSTAINABLE ENERGY PROGRAM
中国可持续能源项目

Three legs of the smart grid

1. Improved operation of the traditional high voltage grid, e.g. through operator visualization technology



2. Improved supply-demand interaction, e.g. through advanced metering infrastructure

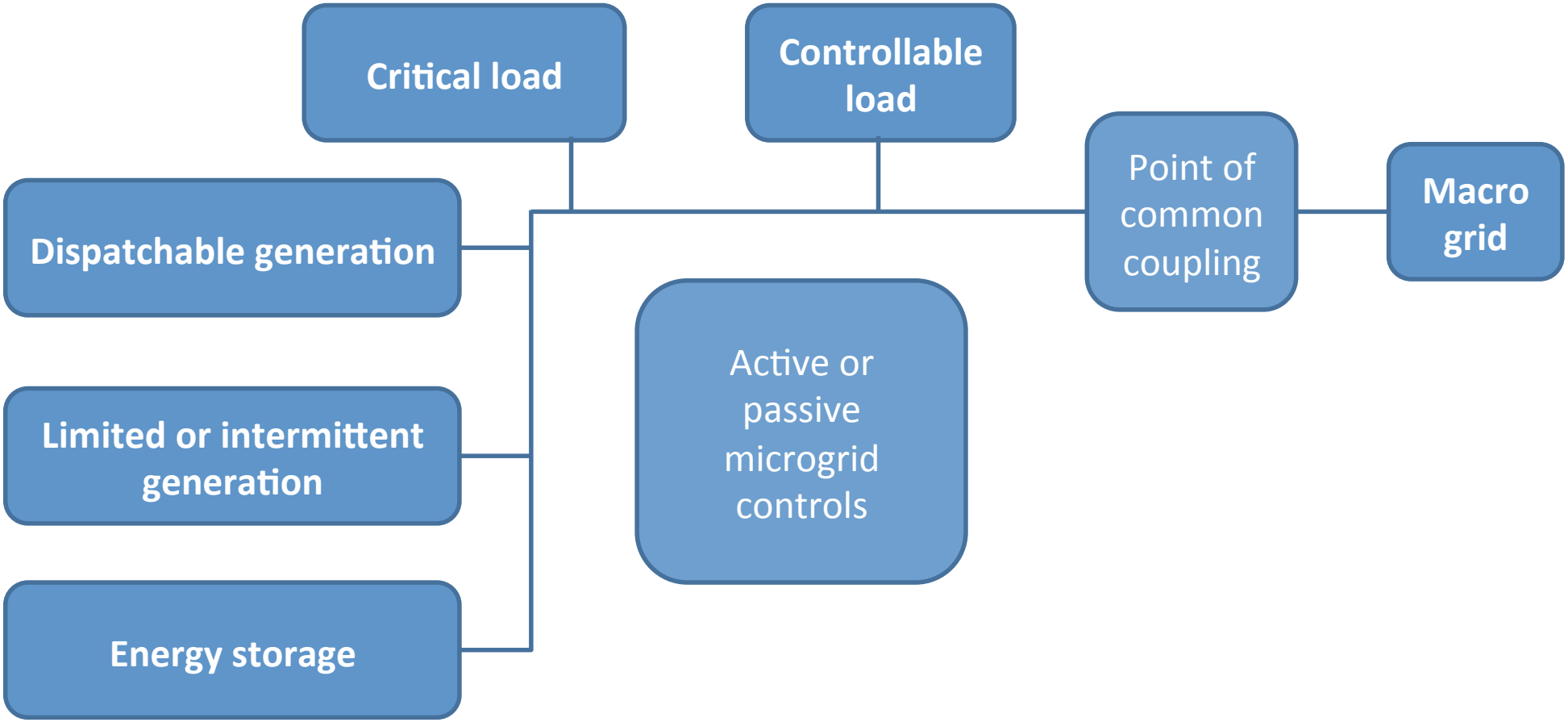


3. Decentralized control and distributed energy resources, e.g. through microgrids



What is a microgrid?

Think: demand response + distributed generation + storage + controls



Why microgrids?





- Limits of macrogrid in control, reliability, efficiency
- Technology innovation and cost reduction
- Business model innovation: from consumer to prosumer

Economic benefits that microgrids offer

Type of benefit	Specific benefit
Economic (direct)	Reduced electricity and fuel costs
	Sale of excess power to grid
	Participation in DR markets
Economic (indirect)	Reduced system congestion costs
	Reduced T&D losses
	Reduced operating reserves
Power quality and reliability	Reduced power outages on-site
	Potential for black-start capabilities
	Potential for reactive power/voltage control
Environmental	Increased use of renewable energy
	Reduced SO2, NOx, CO2 emissions
Security and safety	Avoided major system outages

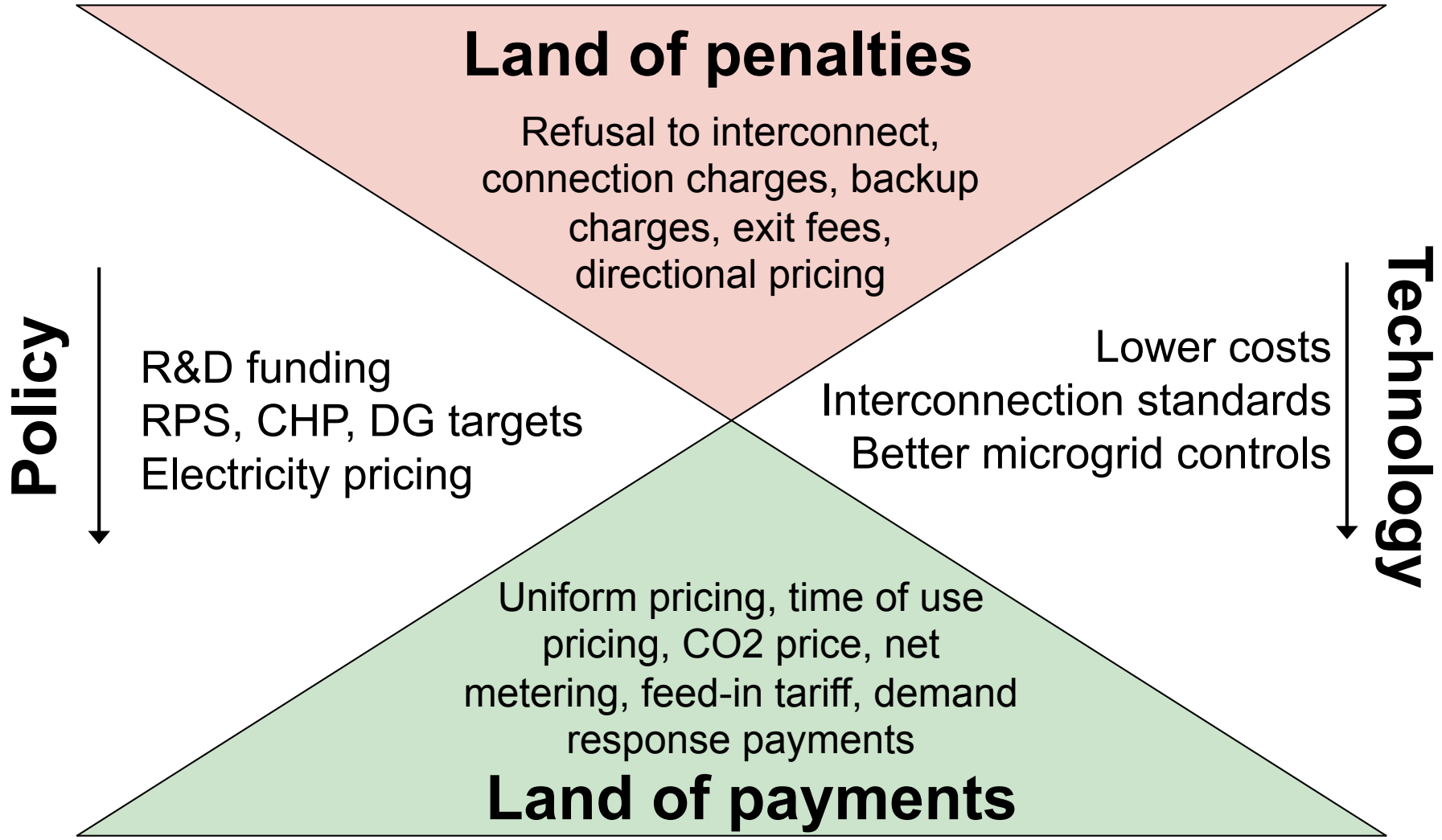
What are the barriers to deployment?

Economic:
Balancing benefits and costs of microgrids

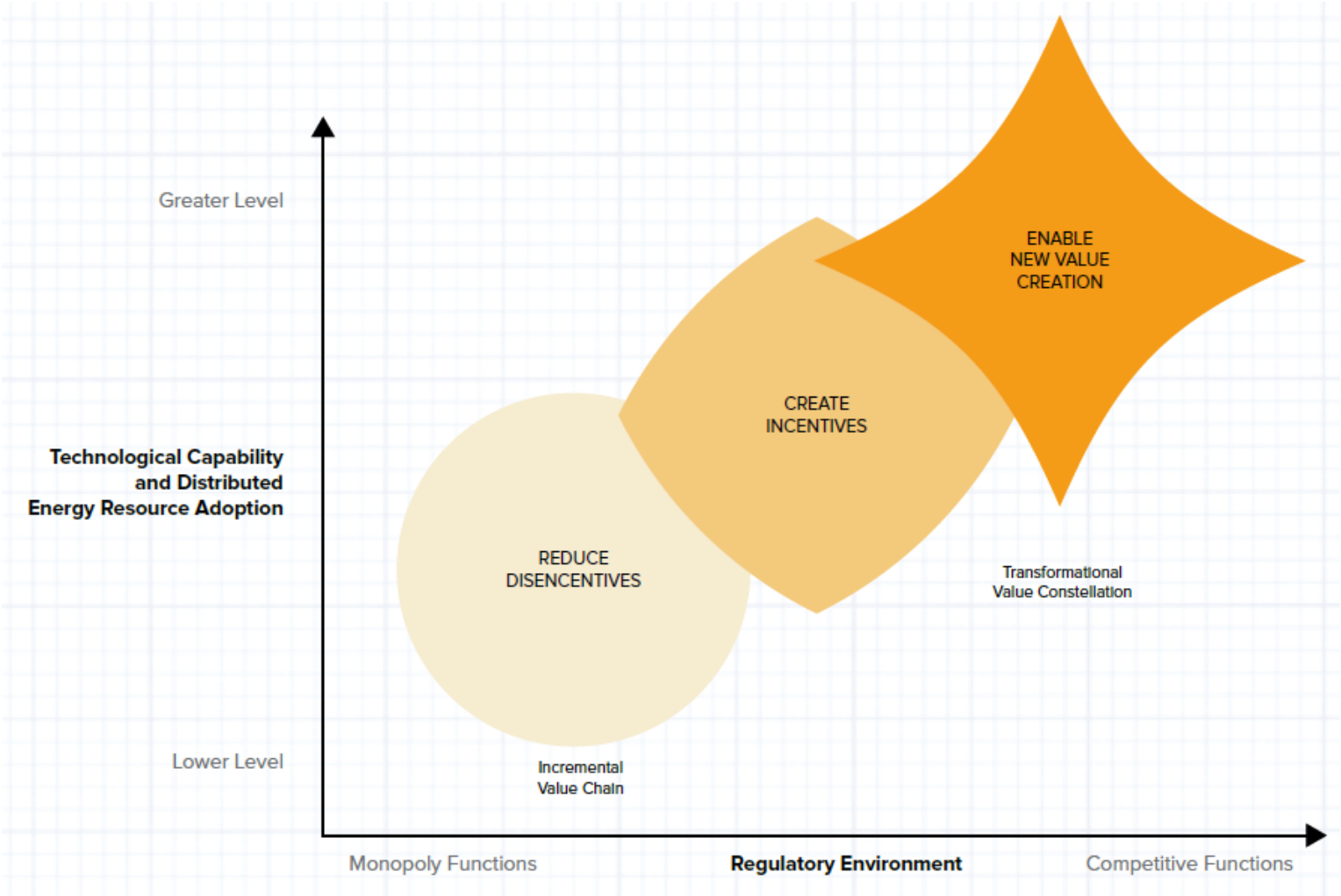
Institutional:
Introducing practices unfamiliar to industry

Technology:
Some costs still remain very high

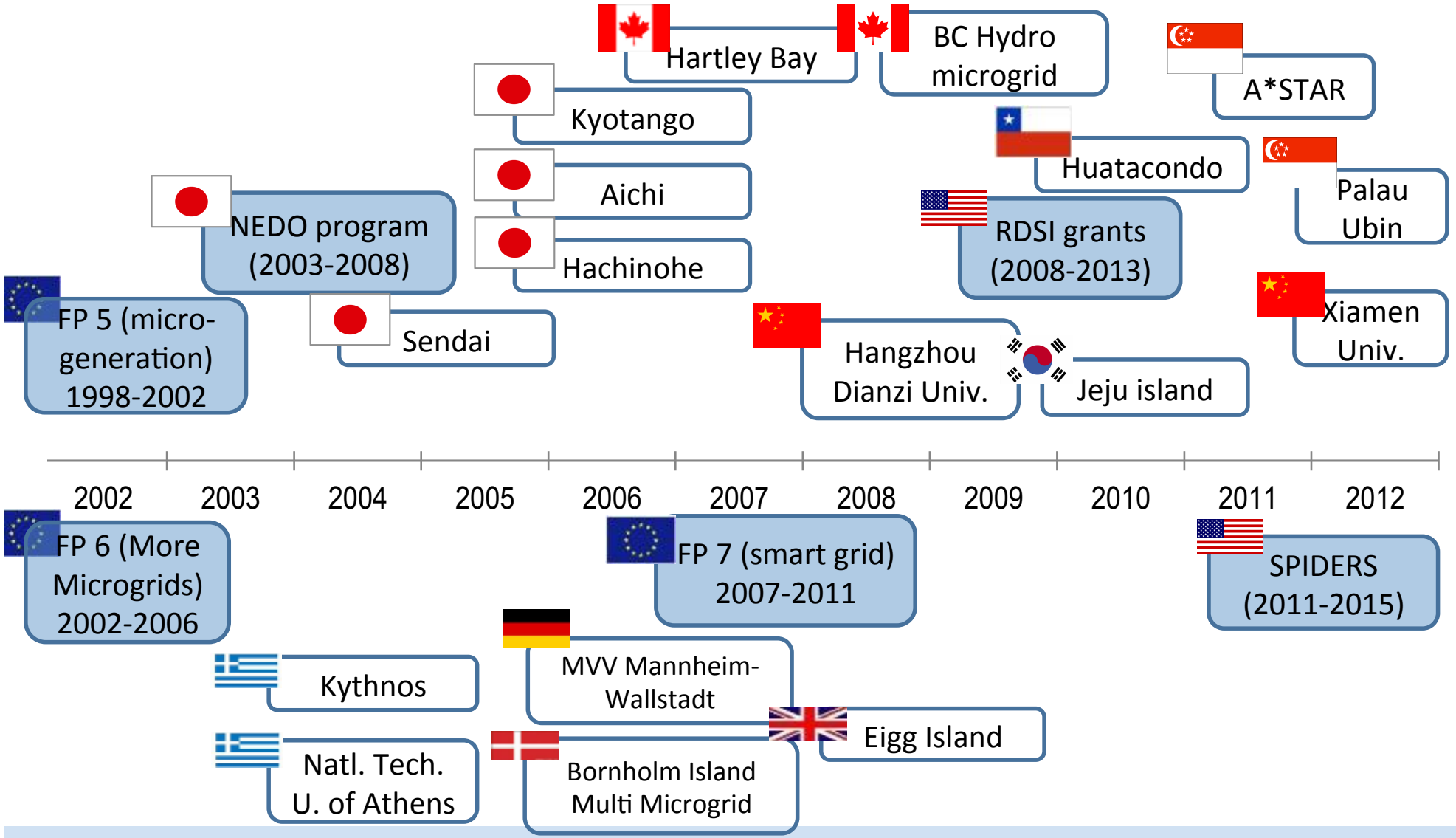
“From the land of penalties to the land of payments”



Enabling new value creation



Microgrid programs to date – international review



Case study: Santa Rita green jail





- **History:** Started in 2002, several phases of technology deployment
- **Technologies used:** Iron-phosphate battery, fuel cell, back up diesel generators, solar PV (rooftop and tracking), islanding switch, microgrid control system
- **Current status:** Fully operational
- **Secrets of success:** Involvement of multiple stakeholders (DOE, CEC, PG&E) each putting up some cost share; focus on reliability and security
- **Lessons learned:** Battery use can lead to big savings in demand charges though overall battery cost was very expensive

Recommendations for China's microgrid program

1

Research and demonstration program

Set the foundation

2

Field demonstration projects

Create initial successes

3

Policy support

Incentivize deployment

Promote a results-oriented demonstration program

Example:

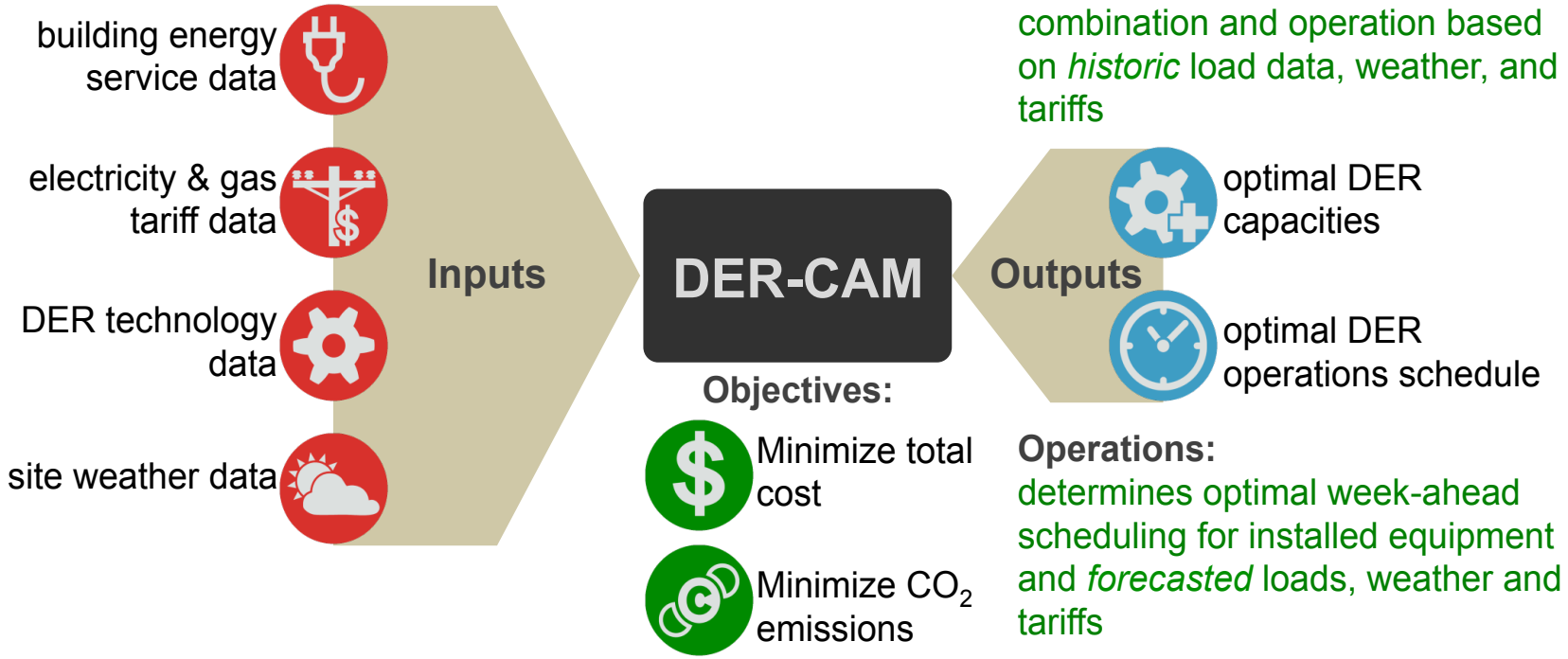
- Peak load reduction on local feeder of 15%
- X% of energy from renewable sources



Cost sharing between government and industry partners should be encouraged

Perform economic evaluations on each project

Optimize investment and operations for the microgrid



Develop standards and processes for interconnection of microgrids

IEEE 1547: Standard for Interconnecting Distributed Resources with Electric Power Systems

IEEE 1547.4: Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems



Thanks!

- Any questions?
- Thanks to Energy Foundation for supporting this project.

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